SAN NICOLAS ISLAND HARBOR STUDY

18 July 1963

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1. PROBLEM

a. History

(1) In 1951-52, the Navy created a small harbor on San Nicolas Island by construction of a breakwater at Coast Guard Beach. Within less than a year after completion, it silted up and became unusable.

(2) In 1955 the Los Angeles District, Corps of Engineers, studies the problem and recommended extension of the breakwater to alleviate the silting (1). This extension was constructed in 1957 and the harbor dredged at the same time. The problem was not solved, and the harbor again silted up in short order.

(3) The harbor was dredged again in the spring of 1963. Re-silting is proceeding at a rapid rate.

(4) The Los Angeles District, CE, made a second study in 1961-2 (2) and has recommended new measures to cope with the problem. These measures are now under consideration.

b. Nature of the Problem

(1) The silting derives from deposition in the harbor of beach sand carried along the shore of the island, primarily by littoral currents created by wave action, and, to a lesser extent, borne by the wind (2). The predominant direction of these currents is to the southeastward, although flow occurs for minor portions of the year in the reverse direction. The magnitude of littoral drift at the harbor has been estimated at 100,000-175,000 c.y. per year (1) and at 144,000 c.y. per year (2).

(2) The essence of a successful solution to the problem lies in the process termed "sand by-passing." In short, the longshore flow of sand, which derives from the natural erosive processes operating on the island, cannot be prevented; it may possibly be deferred or slowed temporarily by expensive construction, but it will continue. The silting-up of the harbor will only be cured by establishing a process whereby the sand can be transported past the harbor in the downcoast (south-east direction), in preference to depositing in the harbor. Any proposed solution which does not recognize this fact - that all the sand arriving at the harbor from upcoast must get past it - is doomed to failure.

(3) The various processes by which sand by-passing might be accomplished are discussed below.

2. LITTORAL DRIFT AND RELATED PROBLEMS - STATE OF THE ART IN ENGINEERING SOLUTIONS

a. Lack of Basic Quantitative Theory

(1) Although a considerable amount of recent literature exists on this subject, there is a paucity of solid, proven theory upon which specific designs may be based. A good deal of qualitative knowledge has been developed as to the mechanics of littoral transport of beach sands, but little to support quantitative design, although research is proceeding in this field (8) (12).

(2) One authority states: "Observations on measured drift rates... are the only reliable data available to those engaged in designing, constructing and maintaining coastal works where the littoral movement of sediment as a problem" (10). Similarly, another observes: "The only reliable method (as of 1962) for quantitative evaluation of littoral drift is by systematic measurements of accretion or erosion rates or both at localities where reasonably complete littoral barriers have been erected or where natural barriers exist" (9).

b. Quantitative Data on SNI Drift.

(1) In 1955 the LA District, CE, estimated littoral drift at 100,000-175,000 c.y per year (1); in 1962 it estimated the annual drift at 144,000 c.y., but stated that such rates "can be determined only by skilled conjecture" (2). These estimates must be received with reservations, as the reports do not indicate that they are based on other than theoretical calculations.

(2) Daily inspector's reports of the dredging done under contract NBy 5433 indicate that from 20 March 1957 to 10 October 1957, the contractor removed more than 154,500 c.y. of material from the harbor. The net change in volume of the dredged area shown by surveys over this period was 93,549 c.y. (11). Furthermore, an extension of the breakwater was built under the same contract, construction commencing 21 June 1957; by 15 July the work had progressed to the point where the extension offered substantial obstruction to littoral drift (which presumably began to accumulate upcoast of the breakwater.) Between 23 October 1957 and 30 December 1957, soundings taken at 2-week intervals showed an average accration rate of only 114 c.y. per day. It can thus be conjectured that, of the 61,000 c.y. accretion which occurred between March and October, approximately 50,000 yards collected between March 20 and July 15.

(3) The harbor was again dredged in the spring of 1963. Soundings taken on June 13, 1963, showed that since the completion of dredging on April 28, an accretion of 32,000 c.y. had occurred (13).

c. Design Data for Geometry of Structures

The same paucity of information, as for littoral drift quantities, occurs on the subject of placement of structures for control of sedimentation and erosion related to littoral drift. Nagai (6) reported model studies on

the placement of groins to control deposition; his conclusions are supported by the experience on San Nicolas Island (that is to say, the breakwater at CoastGuard Beach is, according to Nagai's findings, ideally sited to encourage shoaling in the downdrift lee.) The general state of knowledge on this subject is summarized by Bruun (3): "No general 'formula' or 'theory' exists for proper design of inlets for by-passing, but if favorable natural conditions for by-passing exist this possibility can be tested by model experiments prior to construction..." and again: "Where satisfactory by-passing conditions have been obtained they have either been the result of a long-term (usually expensive) trial and error process or have resulted from hydraulic model experiments."

d. In sum, the present state of knowledge on the subject of littoral drift and its control is such that only limited confidence can be reposed in design proposals based solely on theoretical studies.

3. SAND BY-PASSING - SYSTEMS AND THEIR LIMITATIONS

a. General

(1) The problem of sand by-passing is not unique to San Nicolas Island; it exists at all harbors on coasts where littoral drift is significant, and there is a good deal of recent literature on the subject.

(2) Much of the literature, however, is directed toward instances wherein the primary problem is that of preventing or minimizing beach erosion downcoast of the obstruction which must be by-passed - rather than the prevention of excessive deposits at the obstruction.

b. Systems

(1) Methods by which sand by-passing may be accomplished can be classified as follows:

(a) Natural processes

(b) Fixed structures

(c) Fixed mechanical plant - continuous pumping

(d) Portable mechanical plant - periodic operation

(e) Portable mechanical plant - continuous operation

Each of these will be discussed in turn.

(2) Natural Processes

This approach relies entirely on the forces of nature to accomplish the transport of sediment past the obstacle in question. This obviously will not suffice to maintain the desired harbor at San Nicolas.

(3) Fixed Structures

It may be possible to devise a structure, or system of structures, which will assist natural transport processes in conveying the sediment past the harbor to the downcoast beach. It is stated that breakwaters and jetties for this purpose have been successfully devised for Scheveningen, Holland (3) and Zeebrugge, Belgium (3).

(4) Fixed Mechanical Plant - Continuous Pumping

Such installations have been created at a number of locations. They consist essentially of a dredge pump with a boom-mounted suction capable of drawing from a limited area, and a fixed discharge line terminating at an appropriate location on the downcoast beach.

(5) Portable Mechanical Plant - Periodic Operation

The typical floating dredge falls into this class; however, shore plant - crane and dragline (or clamshell) with truck or barge transportation of the spoil - would likewise be in this category, and were used in the early stages of contract NBy 5433 at SNI in 1957 (11), and elsewhere(5).

(6) Portable Mechanical Plant - Continuous Operation

This likewise might be either floating dredge or shore plant.

c. Limitations on Sand By-Passing Systems

Each of the possible approaches to the problem is subject to certain limitations.

(1) Fixed Structures

(a) Examples wherein a by-passing problem has been solved successfully by structures alone are rare. The Scheveningen and Zeebrugge harbors are the only cases I have found. No criteria for design of structures with this objective in view have been located; despite a concentrated search in the NCEL library and in ASCE literature, which contains much material on the general subject of littoral drift, its effects and related problems.

(b) The LA District, CE, (2) considered as one alternative solution the sequential construction of a number of groins upcoast of the harbor, with the objective of trapping the littoral drift before it reached the harbor. Any such proposal should be approached with great caution.

1. Groins are normally constructed to encourage desposition (or minimize erosion) at the site of the groin. However, there is no basis for assurance that a groin system would trap all, or even the major fraction of the volume of littoral drift reaching the system. It is stated that the active by-passing zone along a shore where littoral drift occurs seems to extend to a 30-foot depth, and even up to 60 feet (3) or

80 feet (7). Construction of groins extending to a 60- or 80-foot depth would be patently uneconomical. I have found no case in the literature of a groin system being constructed primarily to prevent deposition at a specific spot downcoast by intercepting littoral drift at the groin.

2. At best, even if it achieved its intended purpose (of trapping littoral sand flow), the groin system offers only a temporary solution. Once it had filled, the littoral drift and harbor sedimentation would resume.

(c) The possible use of fixed structures in combination with other solutions is discussed below.

(2) Fixed Mechanical Plant - Continuous Operation

A number of such installations are described in recent civil engineering literature. In most cases they have been installed primarily to nourish downcoast beaches against erosion, although a plant for protection of the harbor against shoaling has been built at Salina Cruz, Mexico (4). (The efficacy of this plant has not yet been determined.) They are subject to obvious limitations:

(a) Because of the limited reach of its suction (typically 35- to 50-foot radius), the plant must be located at a spot where it can intercept a maximum amount of littoral drift. Accurate determination of the optimum location may be difficult.

(b) A fixed plant may be subject to difficulties occasioned either by

1. Exhausting the supply of sand available to its suction; or

2. Having the suction choked by excessive shoaling so that the necessary supply of water to the suction is cut off. Such difficulties may require installation of additional equipment, as, for example, a fixed dragline scraper at Salina Cruz (4).

(c) 1. Short-term quantitative rates of littoral drift and deposit may exceed by many times the average annual rate. Thus, a fixed plant proportioned to pass the average flow may be overwhelmed by a rapid build-up of deposits at some seasons.

2. On the other hand, fixed installations may serve to intercept and by-pass only a fraction of the total littoral flow. Thus, at South Lake Worth (Fla.) it is estimated that the fixed plant passes about one-third of the annual drift (4).

(3) Portable Mechanical Plant - Periodic Operation

(a) 1. At SNI only a conventional type of floating dredge

will suffice for operations within the harbor. Shore plant does not have the radius to reach the areas or depths of water required.

2. If the upcoast face of the breakwater served as an effective trap for littoral drift, it might be possible to solve the by-passing problem by continuous dredging with shore plant on the beach just upcoast of the breakwater. However, the history of deposition at Coast Guard Beach does not encourage the prospect of success by such a solution. A recent photograph (14) shows significantly greater beach buildup in the lee of the breakwater than on the exposed side. Personnel stationed at SNI state that this condition occurs periodically. Also, the model studies of Nagai (6) indicate that, in general, scour rather than deposition may be expected along the upcoast face of the breakwater, with deposition occurring in the lee.

(b) In other cases wherein a heavy littoral drift is being by-passed by means of intermittent dredging (e.g. Santa Barbara, Calif.; Port Hueneme, Calif.), the plan provides for a sand reservoir or trap in which the drift can accumulate between dredging cycles. Manifestly, the trap must have sufficient capacity to accommodate the rate of flow and the planned dredging schedule. At SNI the harbor itself is acting as the sand trap.

(c) If periodic dredging is to be employed, a new trap must be created in which the drift will accumulate in preference to entering the harbor. Creation of such a trap will require additional construction, such as the offshore parallel breakwater at the Ventura County Small Boat Harbor, for the Port Hueneme by-pass operation. (Plan "A" of the LA District, CE, (2) envisions the creation of a sand reservoir, without additional construction (other than sealing of the existing breakwater) to assist and protect it; I have reservations as to whether such a scheme would work.)

(4) Portable Mechanical Plant - Continuous Operation

This is the solution recommended by the LA District Engineer (2). It has the advantage of involving a lesser first cost, lesser investment in construction and lesser annual cost than any of the other plans considered by the District Engineer. A principal disadvantage is that it puts NAS Point Mugu into the dredging business on a continuing basis, with its attendant operating problems. Such operations are, in general, contrary to established Navy practice.

4. CURRENT MICON PROJECT

a. Project Description

(1) A MICON Project for FY1965, identified as Line Item Number P-3, Harbor Facilities, San Nicolas Island, was submitted by PMR under date of 7 December 1962. This project consists of repairing and raising the

breakwater; sealing the breakwater against intrusion of sand by the construction of a sheetpile bulkhead along its inner face; construction of a marginal wharf by paving the backfill to be placed between the bulkhead and the breakwater. The estimated cost of this work as originally submitted is $480 thousand.

(2) Subsequent to submission of the project, its scope was increased by including the addition of a downcoast groin. The estimated cost is now $715,000 (15).

b. Project Objectives

(1) The project envisions that, upon its completion, the silting problem will be mastered by:

(a) Periodic removal (with dry-land procedures) of material accreted upcoast of the breakwater;

(b) Maintenance of a berth and channel alongside the marginal bulkhead by dredging with crane and dragline from the pier;

(c) Protection against accretion created by the periodic littoral drift from the southeast, to be furnished by the downcoast groin.

(d) Periodic dredging by contract. (The project description describes this prospective contract dredging as "occasional'; the Public Works Officer, NAS Point Mugu, states that the word 'occasional' is erroneous. The objective of the dredging by crane and dragline is to lengthen the periods between dredging contracts.)

(2) The hope of success of Line Item P-3 in alleviating the SNI problem is apparently predicated on a number of assumptions:

(a) That the porosity of the breakwater is a significant factor in permitting the harbor shoaling;

(b) That sealing the breakwater will cause significant accretions to develop upcoast of the breakwater;

(c) That sand which enters the harbor will deposit in locations where, if it interferes with navigation, it can be removed by dragline from the marginal pier to be built;

(d) That the downcoast groin will intercept all, or essentially all, the littoral drift in the upcoast (northwest) direction, and prevent its entrance into the harbor.

(3) These assumptions must be carefully examined.

c. Project Analysis - Engineering Aspects

(1) The fact that an undetermined quantity of sand passes through

the relatively porous breakwater does not seem subject to challenge. The importance of this condition in the overall problem is a matter of conjecture.

(2) The prospect of success of the sealing of the breakwater in causing the bulk of the littoral drift to accumulate upcoast of the breakwater is open to serious doubt. It is known that, at times, upcoast accretions have been practically nil (14). Also, Nagai's studies (6) suggest that, if the breakwater is sealed, that portion of the sand which now penetrates the breakwater will join a general migration around its tip into the breakwater's lee. In short, the ability of the upcoast face of the breakwater to act as an effective sand trap, which can, subject to periodic dredging, intercept the littoral drift and thus prevent harbor shoaling, is subject to question.

(3) (a) The project envisions that the berth will be kept open by dredging with crane and dragline from the marginal pier to a distance of 100-120 feet. This assumption appears optimistic.

(b) The equipment proposed to be used for this purpose is described as a Manitowoc crane, 3500 LCH, 60-ton capacity, 120-foot boom, 2½ c.y. bucket (18).

(c) 1. For this machine the manufacturer recommends, for general lifting, dragline, or clamshell work, a 70-foot boom of 40-ton capacity. A good working boom angle for dragline work is 26 to 45 degrees. At a 30-deg. angle, working radius of a 70' boom is 60 feet. Although the reach may be increased by casting the bucket, this procedure reduces overall productivity of the machine.

2. It is suggested that, for the proposed service an optimum compromise would be to use a 90-foot boom and 1-c.y. bucket. At 30 deg. boom angle the working radius will be 80 feet (approximately). The estimated maximum capacity with this rig is 760 c.y. daily (eight 60-minute hours) or 3800 c.y. weekly. A more realistic estimate, allowing for minor delays, periodic rest for operator, etc. is perhaps 80% of this figure, or 3040 c.y. per week.

3. Records of soundings at SNI show severe shoaling along the inner face of the breakwater, where the proposed berth is to be established. Efforts to maintain a dredged berth at this point may well create a sand trap which attracts accretion at the most rapid rate. The accretion from 28 April to 13 June 1963 was at a rate in excess of 4900 c.y. per week (13). If a significant fraction of this accretion is attracted to the dredged berth, the crane will have to work continuously on a full-time basis to cope with it.

(4) The efficacy of the proposed downcoast groin in preventing intrusion into the harbor of littoral drift is likewise questionable. It must again be iterated that groins are ordinarily used to encourage deposits on both sides of the root of the groin - not to serve as a dam against littoral

drift. If the groin is to serve the latter purpose, the geometry of its construction and placement must be carefully studied, along the lines indicated by Nagai (6).

(5) In sum: it is far from certain that the construction proposed by Line Item P-3 will achieve the hoped-for results.

d. Project Analysis - Costs

(1) Assuming that Line Item P-3 may represent an acceptable engineering solution, it must still be analyzed from a cost standpoint. The following factors must be considered in such an analysis:

(a) Breakwater, pier and groin

1. Amortization of first cost

2. Maintenance

(b) Sand movement - annual cost

1. Government operations

2. Contract operations

For the sake of uniformity and ease of comparison, the lives (20-and 50-year) and interest rate (2 5/8%) will be taken as identical to those used by the Los Angeles District, Corps of Engineers (2).

(2) (a) Capital costs to amortize $715,000:

20 years	46,400/year
50 years	25,850/year

(b) Maintenance of breakwater, pier and groin: Use $10,000/year as in LA District's Plans A and B.

(c) Sand movement:

1. Assume: annual volume 125,000 c.y./year

50,000 c y./year by Government forces
75,000 c.y./year by contract

Government cost $0.50/c.y.
Contract cost 1.48/c.y (1963 bid price)

2. Annual cost:

Government operations	25,000
Contract operations	111,000
	136,000

(d) Summation

Term	Capital Cost	Maintenance	Moving Sand Government	Moving Sand Contract	Total
20 years	46,400	10,000	25,000	111,000	192,400
50 years	25,850	10,000	25,000	111,000	171,850

(3) The basis for assuming a minimum Government cost of $0.50/c.y. is as follows:

(a) Angas (5) reported a competitive-bid contract price of $0.88 per cubic yard for such an operation. The total contract volume at this price was 250,000 c.y., to be moved in two annual increments during successive winter seasons. While this price had to amortize the construction of several temporary trestles, and of course includes a profit for the contractor, it was in a convenient location (the New Jersey coast); the operation required no equipment for spreading the sand at dumping points, and no maintenance of haul roads; the annual volume is two and one-half times that contemplated by the Government operations.

(b) Seelye (19) (pp. 18-09, 18-10) gives the following cost figures based on operations in the New England-Middle Atlantic area and an ENR Construction Cost Index of 676.4:

1. Earth excavation with dragline, 1½-c.y. bucket - $0.23 to 0.40 per cubic yard, depending on difficulty of operation;

2. Hauling, ½-mile haul, 5-c.y. trucks (not including cost of loading truck) - $0.27 to 0.37 per yard, depending on character of haul road;

3. Thus, these two operations alone would cost from $0.50 to 0.77 per yard. (Seelye's costs do not include mobilization cost nor cost of spreading at dump site.)

The following factors would tend to increase Government costs at SNI:

4. The remoteness of the site

5. Increases in cost index (as of June 13, 1963, ENR indices were as follows:

Los Angeles	991.38
New York	1141.64
Boston	902.26
20 cities average	897.48)

(c) The Los Angeles District, Corps of Engineers, estimated the incremental Government price of moving sand at SNI by hydraulic dredge at $0.50 per yard (2).

5. RECOMMENDATION OF ARMY ENGINEERS

a. During the period 1960-62 the Los Angeles District, Corps of Engineers studies the SNI problem at the request of SouthWest Division, BuDocks; its findings are contained in a report dated April 30, 1962 (2). The LA District considered several alternative solutions, and recommended the purchase of a 12-inch hydraulic dredge, to be stationed at SNI on an essentially permanent basis. The initial capital cost of this solution is estimated at $348,000, and the long-range annual cost (including capital amortization) at $153,000, on either a 20-year or 50-year basis.

b. This solution to the problem has the following advantages over the other approaches considered by the Los Angeles District, and also over Line Item P-3:

(1) Greatest prospect of success

(2) Least initial cost

(3) Least annual cost

(4) In the event of future abandonment of the SNI harbor, possible recapture of part of the capital investment (by sale or transfer of the dredge).

c. This solution has the following disadvantages:

(1) Operation of Government-owned dredges is generally contrary to Navy practice.

(2) This solution would impose on NAS Point Mugu new technical responsibilities related to dredge operation and maintenance.

(3) Since the dredge will operate within the harbor on a more or less continuous basis, periodic conflicts between dredge operation and vessel navigation will occur. A plan which permits required dredging to be carried on outside the harbor would be preferable, if economically competitive.

6. OPERATIONAL CONSIDERATIONS

a. Operational factors were discussed with LCDR King, Surface Operations Department, NAS Point Mugu; his assistant, LT Godfrey; BMC McCall and BM1 Autrey, captains of the YFU's operated to SNI by NAS. They provided the following information:

(1) Beaching conditions - the conditions created by the existing breakwater (without additional improvement) are considered excellent for beaching YFU's;

(2) Weather conditions

(a) Interruptions to surface travel to SNI, occasioned by

weather, may occur during the winter season, December to March. It may be necessary to defer scheduling of trips as much as 25% of the time during this period of the year. Length of postponements may run to 4 days, although the average is one to two days.

(b) HOWEVER - these postponements frequently are occasioned by sea conditions in Santa Barbara Channel, rather than by hazardous beaching conditions at SNI;

(3) Boat damage - no cases could be cited of damage to the YFU's which was attributable to undesirable beaching conditions at SNI.

7. ECONOMIC CONSIDERATIONS

a. Previous Studies

From time to time studies have been made (16) (17) to determine possible monetary savings to be achieved from harbor rehabilitation. The potential annual savings were estimated in 1956 at $60,500 (16) and in 1958 at $78,300 (17). The 1958 study questioned the economic justification of further efforts at harbor rehabilitation.

b.

(1) With the assistance of the supply department, NAS, Pt. Mugu, a review was made of the costs of transportation of material and equipment to and from San Nicolas Island. This study endeavored to cover all costs to the Government; it includes payments for contract barge operations, direct charges to NAS allotments, and allowance for amortization of capital on Government equipment; it covers operations out of both Port Hueneme and San Pedro. The total annual transportation and handling cost of such shipments (based on three-year averages, FY 61-63 inclusive) is estimated at $275,000 (22).

(2) The principal potential savings estimated in 1956 and 1958 arose from the possibility of berthing an AVR for Air-Sea Rescue work at SNI, thus reducing a daily round trip between Port Hueneme and SNI to a weekly trip. The saving available from this source was estimated in 1956 and 1958 at $45,400 (16) (17). Allowing for cost escalation since the original estimate, an estimated saving of $55,000 may be credited to ASR operations.

c. A number of factors complicate the problem of estimating savings in transportation and handling costs to be derived from maintenance of a protected harbor.

(1) The 1956 study points out that (for ease of unloading at the beach) cargo is carried to SNI in trucks and trailers lifted by the contract barge or YFU. (An allowance for rental or amortization of these trucks is included in the annual cost figure of $275,000.) If the trucks and trailers were eliminated, the net vessel capacity available for useful cargo would be increased and the frequency of trips could be reduced, with consequent saving in cost.

(2) This reasoning is counterbalanced, at least in part, by the fact that the scheduling of trips is influenced, not only by volume of cargo and lifting capacity of vessels, but also by operational considerations (23). The barge and YFU's are not always scheduled for capacity loads. The extent to which trip frequency could be reduced by having a pier to operate over at SNI, and eliminating the trucks and trailers from analysis of the complete cargo activity and the operations which it supports. This analysis has not been undertaken.

(3) It is worthy of remark that, if the net cargo capacity of the vessels were utilized by handling material in pallets, crates, and cargo nets, there would probably be an increase in costs of crating and in handling between pier and vessel (at both PH and SNI). This increase (estimated in 1956 at $5,256 (16)) serves as a partial offset to any savings to be derived from the decrease in trip frequency.

d. It has also been suggested that the proposed construction will effect savings by eliminating or reducing personnel injury and damage to vessels and cargo occasioned by over-the-beach operation. I have not been able to obtain firm data on which to establish that such savings are, in fact, likely.

e. Another suggested source of potential saving has been the cost incident to delay of major range operations which might be attributable to lack of a fully maintained harbor. No firm data or examples were offered in support of this possibility. While I recognize that such a saving might be considerable, it would require a detailed study of PMR operations and the role of SNI therein to support any dollar figure assignable to this justification. I have not undertaken such a study.

f. On the basis of the following premises:

(1) The least annual cost of maintaining the harbor is $153,000 (2);

(2) The present annual cost to the Government of cargo operations to SNI is $275,000 (subpara b (1) above);

(3) An annual saving of $55,000 can be realized by providing safe means of stationing an AVR at SNI (subpara b (2) above);

It will be seen that, to justify maintaining a harbor on the basis of savings in logistic operations, the cost of such operations must be reduced by $98,000, or 35.6%. It is to be doubted that harbor improvement and maintenance will bring about a saving of this magnitude.

g. I recognize that operational considerations, not reducible to dollar costs, may warrant the maintenance of a harbor at SNI. A study of such factors is considered to be outside the scope of this report.

8. MODEL STUDIES

a. It has been indicated earlier in this paper (para 2.c.) that model studies offer the only reliable basis at the present time for design of structures and systems to control littoral drift. Consideration has been given to the applicability of a model study in solving the problem under consideration.

b. Sedimentation problems are difficult to study through models because of the scaling problems related to size and density of the sediment. The Waterways Experiment Station of the Corps of Engineers has enjoyed success in such studies through the use of gilsonite. However, this material is difficult to handle, and similarity between model and prototype must be developed by expensive verification tests ((20), pp. 171-2).

c. An informal effort was made, through the L. A. District, Corps of Engineers, to obtain from the Beach Erosion Board a rough estimate of the possible cost of such a model study. This effort did not develop any specific figures, although the BEB indicated willingness to consider the subject if approached officially via the L. A. District. Unofficially, BEB personnel expressed the opinion that the solution proposed by the L.A. District was the best available under the circumstances (21).

CONCLUSIONS AND RECOMMENDATIONS

a. Conclusions

(1) the MICON FY 65 project, Line Item P-3, Harbor Facilities, San Nicolas Island, is of questionable value from an engineering standpoint. The prospects of this plan's successfully solving the harbor maintenance problems are uncertain.

(2) On an annual cost basis, even if successful, Line Item P-3 will cost more than the alternative favored by the L. A. District, that of stationing a hydraulic dredge at SNI.

(3) It does not appear that the annual cost of maintaining an improved harbor at SNI can be recouped to the U. S. Treasury in the form of reduced operating costs incident to logistic support of the island. Thus, on an economic basis, harbor improvement and maintenance does not appear justified.

(4) Under the present state of knowledge, hydraulic model studies offer the only reliable basis for design of structures intended to control littoral drift problems. Any additional construction performed at SNI, without benefit of such studies prior to final design, is likely to have only limited success.

b. Recommendations

(1) Unless operational requirements exist which transcend the cost considerations covered herein, defer efforts to improve or maintain the harbor at San Nicolas Island. Continue to operate over the protected beach created by the breakwater, in the fashion which has prevailed for the past several years.

(2) If an improved harbor is necessary, proceed in accordance with the recommendation of the Los Angeles District, Corps of Engineers, 30 April 1962 - that is to say, purchase a hydraulic dredge and station it at SNI on an essentially permanent basis.

(3) Defer further action on MICON FY 65 project, Line Item P-3, Harbor Facilities, San Nicolas Island, until it is established by model studies that this plan offers a reasonable prospect of solving the harbor maintenance problem.

(4) Before any more construction is undertaken on the SNI harbor, make sufficient hydraulic model studies to establish that the work proposed will actually accomplish intended results.

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REFERENCES

(1) Los Angeles District, Corps of Engineers, U. S. Army, Engineering Study for Preparation of Design of Groins in Connection with Rehabilitation of Harbor Facilities at San Nicolas Island; request for (letter to Commander, U. S. Naval Air Missile Test Center, Point Mugu, California, File No. SPLGB800.925 (San Nicolas Island), 17 January 1955).

(2) U. S. Army Engineer District, Los Angeles, Report on Engineering Study of San Nicolas Island, California for Southwest Division, Bureau of Yards and Docks, Department of the Navy, San Diego, California, April 30, 1962

(3) Bruun, Per, and F. Gerritsen, Natural By-Passing of Sand at Coastal Inlets, WWHJ, December 1959, PP. 75-107

(4) Hall, Jay V. Jr. and George M. Watts, Beach Rehabilitation by Fill and Nourishment, Transactions ASCE, Vol 122, 1957, pp. 155-177

(5) Angas, W. Mack, Shark River Inlet San By-Passing Project, WWHJ, September 1960, pp. 29-67.

(6) Nagai, Shesitiro, Arrangement of Groins on a Sandy Beach, WWHJ, September 1956, pp. 1063-1 to 1063-13.

(7) National Marine Consultants, Inc., Santa Barbara, California, Oceanographic Study, San Nicolas Island, California, August 1961 (included in reference (2), U. S. Army Eng. Dist., L. A., report of 4/30/62)

(8) Savage, Rudolph P., Laboratory Determination of Littoral-Transport Rates, WWHJ, May 1962, pp. 69-92

(9) Watts, George M., Mechanical By-Passing of Littoral Drift at Inlets, WWHJ, February 1962, pp. 83-99

(10) Johnson, J. W., The Littoral Drift Problem at Shoreline Harbors, WWHJ, April 1957, pp 1211-1 to 1211-37.

(11) Records of contract NBy5433, Specification 5433/56, Rehabilitation of Harbor Facilities and Construction of Submerged Fuel Transfer Lines, San Nicolas Island, U. S. Naval Air Missile Test Center, Point Mugu, California, Clyde W. Wood & Sons, Inc., Contractor - Box 31, Record Group 181, Federal Records Center, General Services Administration, 555 Eastern Ave., Bell, California

(12) Massachusetts Institute of Technology, Educational and Research Activities in Civil Engineering at the Massachusetts Institute of Technology, January 15, 1963, p. 16.

(13) Browning, C. V., Director, Engineering Division, Public Works Department, Naval Air Station, Point Mugu, California, in telephone converstation with Captain M. H. Jordan, 19 June 1963.

(14) Photograph, HQ, PMR, NMC, Point Mugu, California, LAW-52426-L-10-61, 10-27-61.

(15) DIRSOWESTDOCKS ltr Serial 3547/E-250, 11 April 1963, to COMPMR.

(16) Memorandum, R. B. Holst to Dr. Weller (PMR HQ) RBH:bn(CEN1a), 16 July 1956

(17) Memorandum, CEN-26 to CEN-1, 6 March 1958, (Signed "R.E. Boise"), San Nicolas Island Harbor Rehabilitation; justification of

(18) Data furnished by Planning Division, PWD, NAS, Point Mugu

(19) Seelye, Elywn E., Specifications and Costs (1957 edition).

(20) Rouse, Hunter, ed., Engineering Hydraulics - Proceedings of 4th Hydraulic Conference, Iowa Institute of Hydraulic Research, June 12-15, 1949.

(21) Phonecon, Mr. Robert Loudoun, L. A. District, CofE, and CAPT Jordan, 5 July 1963.

(22) Notes on detailed analysis of this cost figure are held by Code 19332, PMR Staff.

(23) Phonecon between Mr. James Tedder, Supply Department, NAS, Point Mugu, and CAPT M. H. Jordan, 18 July 1963.

GENERAL REFERENCES

Beach Erosion Board, Corps of Engineers, U. S. Army, Shore Protection Planning and Design, Technical Report No. 4, 1961.

Public Works Department, Naval Air Station, Point Mugu, California, Harbor SNI Rehab. (3-ring binder of historical material)

NOTE: "WWHJ" = Journal of Waterways and Harbors Division, American Society of Civil Engineers (ASCE).

Looking west from base of breakwater showing sand fences.
Tide + 3 feet

Looking east from site of Groin #2.
Tide + 3 feet

Looking west from site of Groin #2.
Tide + 3 feet

Looking east at site of Groin #4.
Tide + 3 feet

Looking west from site of Groin #4.
Tide + 3 feet

Looking east at site of Groin #5.
Tide + 3 feet

Looking west from site of Groin #5.
Tide + 3 feet